NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3210 FINAL EXAM 12/98 Prof. Powers

- This exam is open book and notes.
- There are five problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be sure to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.
- Enter your name in the space provided.
- Exams and course grades *should* be available outside the Optical Electronics Laboratory (Bu 224) on **Friday afternoon, 18 December**.
- Have a good holiday season and enjoy your break!

Course grade: _____

1		4	
2		5	
3			
TOTAL			

Name: _____

1. A mode-locked laser operating at 1.06 mum produces pulses that have a peak power of 10 mW. The average power from the laser is 100 μW and the measured pulse-width is 100 ps. Calculate the mirror spacing of the resonator if the index of refraction of the lasing medium is 1.5.

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2. A Gaussian laser beam ($\lambda = 800$ nm) propagates from left to right. The beam has a spot size of 8 mm and a radius of curvature of phase of +15 m at a location that is 25 m from the origin of the $x - y - z$ coordinate system). Find the beam spot size *and* radius of curvature of the phase at a location that is -9.5 m from the origin.

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3. The carbon-monoxide (CO) laser is a four-level laser whose energy levels have the properties listed below. The laser operates at a cryogenic temperature of 77K at a pressure of 10 Torr. Write an expression for the linewidth function $g(\nu)$ if the laser is lifetime and collision broadened. (The collision cross-section for a CO–CO collision is 7.03×10^{-21} m^{-2}.)

Energy level	Energy (eV)	Lifetime (μs)
3	3.10	1.0×10^{-3}
2	1.91	2.0
1	1.5	0.10
Ground	0	∞

(Note: This data is fictitious and does not represent the properties of an actual CO laser.)

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4. A laser resonator has a mirror spacing of 25 cm. The two mirrors of the resonator have equal power reflectivities of 98%. One mirror has a radius of curvature of 50 cm. For what range of values of radius of curvature of the second mirror will the laser resonator be capable of producing a TEM_{00} wave.

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5. A light wave ($\lambda = 633$ nm), described by the vector

$$\vec{\mathbf{E}}_{\mathrm{in}} = 1\cos(\omega t - kz)\,\hat{\mathbf{a}}_x - 1\sin(\omega t - kz)\,\hat{\mathbf{a}}_y\,, \tag{1}$$

is incident on a waveplate made of ADP with a thickness of 6 μm. (The vectors $\hat{\mathbf{a}}_x$ and $\hat{\mathbf{a}}_y$ are unit vectors in the x and y directions.) The fast axis of the waveplate is oriented along the x-axis. Find an expression for the vector $\vec{\mathbf{E}}_{\mathrm{out}}$ at the output of waveplate.